Prevalence and sociodemographic factors of malnutrition among children in Malaysia

Amina Z. Khambalia, Siew S. Lim, Tim Gill, and Awang M. Bulgiba

Abstract

Background. *For many developing countries undergoing rapid economic growth and urbanization, trends in nutritional status indicate a decrease in malnutrition with an associated rise in the prevalence of obesity. An understanding of the situation among children in Malaysia is lacking.*

Objective. *To examine the prevalence, trends and sociodemographic factors described for underweight and overweight children in Malaysia.*

Methods. *The literature from January 1996 to November 2010 on the prevalence of underweight and overweight among children in Malaysia was reviewed.*

Results. *Twelve studies were identified that reported on both underweight and overweight among children in Malaysia, of which only one was a nationally representative survey. Based on the National Health and Morbidity Survey in 2006, 13.2% (95% CI, 12.6 to 13.9) of children aged 0 to 18 years were underweight (weight-for-age < –2SD), and 8.0% (95% CI, 7.5 to 8.6) of those aged 0 to 13 years were overweight (weight-for-height > +2SD). Both underweight and overweight were more prevalent in males than females. Children in rural areas were more likely to be underweight and less likely to be overweight than urban children. Ethnic differences between Malays, Chinese, and Indians were inconsistent across studies and less clear. Aborigines were more likely to be underweight and less likely to be overweight than the general population. The available evidence, although limited and sparse, suggests that over the past decade the prevalence of both underweight and overweight among children in Malaysia has been stable or has shown an increasing trend.*

Conclusions. *Long-term national monitoring and longitudinal cohort studies will be critical for understanding, preventing, and managing the double burden of malnutrition among children in Malaysia.*

Key words: Adolescent, children, epidemiology, malnutrition, overweight, undernutrition

Introduction

Globally, the World Health Organization (WHO) estimates that 170 million children are underweight and at least 20 million children under 5 years of age are overweight [1]. In lower- to middle-income countries in Asia, Africa, the Middle East, and Latin America, large segments of the population face undernutrition and poverty-related diseases, while increasing proportions of the population are developing obesity and noncommunicable diseases such as diabetes and coronary problems [2]. The co-occurrence of overnutrition and undernutrition is attributed to the "nutrition transition"—a term used to describe shifts in diet, physical activity, health, and nutrition [3]. The nutrition transition is characterized by a shift toward more energy-dense diets and a reduction in physical activity due to higher incomes and the influence of mass media and food marketing [2].

The economic conditions of a country are usually related to changes in diet and physical activity patterns that contribute to obesity and chronic disease [4]. Statistics from several ministries in Malaysia over the past two decades show a rise in the size of food importation bills, reflecting increased intakes of energy,

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fats, and sugars with increasing population affluence [5]. Furthermore, there has been an increase in the number of fast-food outlets in Malaysia during the past decade [6]. Data from food balance sheets show increases from 1961 to 1997 in the consumption of calories (from 2,430 to 2,990 kcal/person/day), protein (from 49 to 61 g/person/day), and fat (from 49 to 87 g/person/day) [6]. A summary of the evidence of the nutrition transition in Malaysia also refers to several studies showing low physical activity levels among adolescents and adults [6]. As proxies for increased sedentary lifestyles, the number of motor vehicles increased threefold from 2.3 million in 1980 to 7.6 million in 1997, and ownership of television sets increased from 1.1 million to 2.4 million during the same period [6].

Globalization and urbanization are the major forces underlying the nutrition transition [7]. Over the past three decades, Malaysia has undergone considerable economic growth [8]. Life expectancy, education, income, gross national product, and the rate of urbanization have all shown dramatic increases [9]. To date, there has been no systematic summary or appraisal of the situation of underweight and overweight children in Malaysia. Therefore, the aims of the present study were to examine the prevalence, trends and socioodemographic factors described for underweight and overweight children in Malaysia.

Methods

Relevant literature from January 1996 through November 2010 was identified by a structured search in PubMed, Medline, and Embase. Selection of the study period was based on evidence that Malaysia has undergone a nutrition transition in the past two decades and the fact that the first national survey to report on the nutritional status of children in Malaysia was conducted in 2006. Combinations and variations of the search terms "Malaysia," "underweight," "overweight," "obesity," "prevalence," and "children" were used. Other sources included national reports, the reference lists of included papers, and e-mails to the investigators of included studies requesting further studies not identified in the electronic search. Studies were included if the study setting was in Malaysia and outcome measures included the prevalence of underweight and overweight among children 0 to 18 years of age. Studies were excluded if the study population was selected on the basis of a specific disease or disorder or if the study design was a case–control or case report.

Information on the characteristics of the studies (authors, year, study design, population, sample size, type of measurements, outcome definitions, and results) was extracted from the studies and presented in tables. Units of measurement (e.g., z-scores, percentiles) and age groups of children varied between studies. Only one nationally representative survey reported a measure of variance (standard deviation or standard error). Given the heterogeneity in age groups and in definitions of underweight and overweight, the data synthesis plan involved grouping studies according to their definitions of underweight and overweight to describe the prevalence and sociodemographic distribution (sex, age, ethnicity, and locality) of underweight and overweight children where data were available.

Results

General description of studies

Twelve studies were identified that reported on both underweight and overweight children in Malaysia, of which only one was a nationally representative survey (**table 1**) [10–24]. Various criteria and standards were used to define nutritional status across the studies (**table 1**) [25–30]. Among children 0 to 13 years of age, the prevalence of overweight was 5.3% (95% CI, 4.5 to 6.2) when overweight was defined as weight-for-age > +2SD and 8.0% (95% CI, 7.5 to 8.6) when overweight was defined as weight-for-height > +2SD [12]. Less discrepancy between estimates for overweight children using different methods was found in one of the smaller cross-sectional studies that was conducted a decade earlier in 1996 [20]. Tee et al. found that the prevalence of overweight children aged 7 to 10 years was 8.4% when overweight was defined as weight-for-age > +2SD and 7.7% when overweight was defined as weight-for-height > +2SD [20]. Greater variation between the estimates of overweight prevalence among children found in the Third National Health and Morbidity Survey (NHMS-3) using the different classifications for overweight children may be related to the broader age range (0 to 13 years in NHMS-3 compared with 7 to 10 years in the study of Tee et al.). It is disappointing that the NHMS-3 did not use different classifications for overweight children in various age groups [12].

Prevalence of underweight and overweight

The highest-quality data were from a single nationally representative survey. The NHMS-3 conducted in 2006 used z-scores of weight-for-age and found that among children 0 to 18 years of age, 13.2% (95% CI, 12.6 to 13.9) were underweight and 5.4% (95% CI, 5.0 to 5.7) were overweight (**tables 2** and **3**) [12]. Estimates from the same survey based on weight-for-height (provided only for children aged 0 to 13 years) found prevalence rates of underweight and overweight of 10.4% (95% CI, 9.8 to 11.1) and 8.0% (95% CI, 7.5 to 8.6), respectively [12]. Eight of the 12 studies were conducted in

TABLE 1. General description of cross-sectional studies reporting on the prevalence of underweight and overweight among children and adolescents in Malaysia

Author, year	Study objectives	Study year	Study setting	Age (yr)	Sample size	Sampling frame and technique	Reference standard
Chee, 2008 [10]	Determine weight status and dietary intake	2006	Kuala Lumpur	6–17	53	Welfare home (n = 1)	BMI-for-age (CDC, 2006) [25]
Foo, 2006 [11]	Determine dietary intakes	NR	Sabah	12–19	199	Fishing villages (n = 6)	BMI-for-age (WHO, 1995) [29]
MOH, 2008 [12]	Third National Health and Morbidity Survey	2006	National	0–18	22,032	2-stage stratified sampling proportionate to population size	Weight-for-age and weight-for-height (NCHS/WHO, 1983) [27, 28]
Moy, 2004, 2006 [13, 14]	Describe body mass status	1994/95	Kuala Lumpur	11–16	3,620	Multistage sampling of private and government schools (n = 29)	BMI-for-age (WHO, 1995) [29]
Muhammad, 2008 [15]	Determine parental perception of child's weight status	NR	Kuala Lumpur	9–12	204	Primary school (n = 1)	BMI-for-age (CDC, 2006 [25]; IOTF, 2000 [26]
Rampal, 2003 [17]	Determine nutritional status	NR	Selangor (Peninsular Malaysia)	6–10	208	Village (n = 1)	Weight-for-age (NCHS/WHO, 1983) [27, 28]
Rampal, 2007 [16]	Determine prevalence of overweight	2005	Selangor (Peninsular Malaysia)	13–17	3,333	Random cluster of secondary schools (n = 35) proportionate to size	BMI-for-age and -sex (WHO, 1995) [29]
Saibul, 2009 [18]	Determine dual burden of malnutrition among Orang Asli	2002–05	Selangor (Peninsular Malaysia)	2–9	182	Households (n = 339) in Temuan and Mahmeri villages	Z-scores (NCHS/WHO, 1983) [27, 28]
Soo, 2008 [19]	Determine eating behavior, body image, and self-esteem	NR	Peninsula	15–17	489	Randomly selected secondary schools (n = 7) and year 4 female students (n = 489)	BMI-for-age (WHO, 1995) [29]
Tee, 2002 [20]	Determine nutritional status	1996	Kuala Lumpur	7–10	5,995	Randomly selected every 10th child on master list of students. Sampled 166 schools (97.6% of all schools and 7.8% of all 7- to 10-yr-old primary schoolchildren in Kuala Lumpur)	Z-scores (NCHS/WHO, 1983) [27, 28]and BMI-for-age (NHANES-1,1991) [30]
Zaini, 2005 [21]	Determine factors affecting nutritional status	NR	Selangor (Peninsular Malaysia)	9–10	1,373	Randomly sampled primary schools (n = 53).	BMI-for-age and -sex (IOTF, 2000) [26]
Zalilah, 2000 [22]	Determine nutritional status	1997/98	Kuala Lumpur	6–10	8,005	Multistage random sampling of primary schools (n = 21). Year 1–3 schoolchildren with low-income parents	Z-scores (NCHS/WHO, 1983) [27, 28]
Zalilah, 2006 [23, 24]	Determine dietary habits, physical activity, nutritional status, and body image	2001–03	Penang and Kedah	11–15	6,555	Multistage random sampling of secondary schools (n = 14)	BMI-for-age and -sex (WHO, 1995) [29]

BMI, body mass index; CDC, Centers for Disease Control and Prevention; IOTF, International Obesity Task Force; MOH, Ministry of Health; NCHS, National Center for Health Statistics; NHANES, National Health and Nutrition Examination Survey; NR, not reported; WHO, World Health Organization

school-based settings among primary or secondary students (**table 1**). Prevalence estimates for underweight among both boys and girls were available from 12 studies and ranged from 1.2% to 58.3% (**table 2**). For boys and girls combined, the prevalence of overweight from 13 studies ranged from 0% in an sample of indigenous Orang Asli children [18] to 27.4% in a sample of primary school students in Kuala Lumpur (**table 3**) [15].

A limitation of the research studies identified is the use of not only disparate, but sometimes inappropriate, methods for defining overweight (**table 1**). For example, a few studies used weight-for-age to define weight status in children[17, 22]. Although weight-for-age has been the preferred method for defining underweight, its value in defining overweight is limited [31]. The NHMS-3, which contains the most current and representative anthropometric data in children and adolescents in the country, defined overweight status in children using both weight-for- age and weight-for-height methods [12].

Trends over time

Examining trends proved difficult, for two major reasons. First, multiple years of nationally representative data on the nutrition status of children are not available in Malaysia. Second, only 3 of the 13 smaller studies reported the year when the study was performed (**table 1**). Comparisons between the study year and the publication year indicate that the two cannot be assumed to be equivalent. For example, the study by Tee et al. published in 2002 was conducted in 1996 [20]. Proper reporting of the study year is important to permit examination of trends over time and comparison of small studies with similar populations (e.g., urban secondary school students). An e-mail was sent to all investigators with an included study in the present review requesting the year that the study was conducted. Additional information was received for two papers.

The limited available evidence suggests a possible increase in the prevalence of underweight among urban children in Malaysia over the past decade. The prevalence was 7.1% when underweight was defined as weight-for-age < –2SD in 1996, 10% when underweight was defined as body mass index (BMI)-for-age < 5th percentile) in 2005, and 11.4% (95% CI, 10.7 to 12.2) when underweight was defined as weight-for-age < –2SD) in 2006. Similarly, the limited data on overweight children suggest a possible increase among urban children from 7.7% in 1996 (when overweight was defined as weight-for-height > 2SD) to 8.2% (when overweight was defined as BMI-for-age > 95th percentile) in 2005, to 8.8% (95% CI, 8.1 to 9.6) when overweight was defined as weight-for-height > 2SD. Among studies that report the survey year, there is no clear pattern over time for those with the same

TABLE 2. Prevalence of underweight among children and adolescents in Malaysia

		Prevalence—% (95% CI where reported)				
Cutoff	Author, year	Both sexes	By sex	By age	By ethnicity	By locality
BMI-for-age < 5th percentile	Chee, 2008 [10]	21	NR	6–9 yr: 38 10–17 yr: 15 $p = .16$	NR	NR
BMI-for-age < 5th percentile	Foo, 2006 [11]	19.6	Boys: 25.5 Girls: 14.3	NR	NR	NR
BMI-for-age < 5th percentile	Moy, 2004, 2006 [13, 14]	14.8	Boys: 16.2 Girls: 13.3	Standard 5: 16.1 Form 2: 15.1 Form 4: 12.8	Malay: 15.9 Chinese: 10.9 Indian: 21.1	NR
BMI-for-age < 5th percentile	Muhammad, 2008 [15]	14.8	NR	NR	NR	NR
BMI-for-age < 5th percentile	Rampal, 2007 [16]	10.0	Boys: 8.7 Girls: 6.3	13 yr: 11.4 14 yr: 10.7 15 yr: 8.1 16 yr: 9.3 17 yr: 10.2	Malay: 8.7 Chinese: 8.4 Indian: 17.2 Others: 9.1	NR

BMI-for-age < 5th percentile	Zalilah, 2006 [23, 24]	11.4	Boys: 14.8 Girls: 7.9	11–12 yr: 11.4 13 yr: 11.9 14–15 yr: 10.6	Malay: 11.9 Chinese: 7.2 Indian: 19.2	Urban: 10.3 Rural: 12.1
BMI-for-age < 5th percentile	Soo, 2008 [19]	NA	Boys: NI Girls: 3.1	NR	NR	NR
BMI < 16 and weight < 20 kg	Zaini, 2005 [21]	1.2	Boys: 0.7 Girls: 1.6	NR	Malay: 1.6 Chinese: 0 Indian: 0.8	Urban: 0.9 Rural: 2.2
Weight-for-age < –2SD	MOH, 2008 [12]	13.2 (12.6–13.9)	Boys: 14.5 (13.7–15.3) Girls: 12.0 (11.3–12.7)	< 1 yr: 7.1 (5.7–8.9) 1–3 yr: 19.8 (18.4–21.3) 4–6 yr: 16.4 (15.2–17.6) 7–9 yr: 11.9 (10.8–13.0) 10–13 yr: 9.2 (8.3–10.1) 14–15 yr: 10.2 (9.0–11.6) 16–18 yr: 16.0 (14.3–17.7)	Malay: 14.3 (13.6–15.0) Chinese: 5.2 (4.4–6.1) Indian: 10.5 (8.8–12.5) Other bumis: 18.4 (16.6–20.5)[a] Others: 18.9 (14.7–23.9)[b]	Urban: 11.4 (10.7–12.2) Rural: 16.0 (15.1–17.2)
Weight-for-age < –2SD	Rampal, 2003 [17]	11.1	Boys: 13.1 Girls: 9.2 $P > .05$	6 yr: 11.9 7 yr: 15.4 8 yr: 8.9 9 yr: 8.7 10 yr: 11.1 $p > .05$	NR	NR
Weight-for-age < –2SD	Saibul, 2009 [18]	58.3	NR	NR	NR	NR
Weight-for-age < –2SD	Zalilah, 2000 [22]	14.5	Boys: 16.6 Girls: 12.1	NR	NR	NR
Weight-for-age < –2SD	Tee, 2002 [20]	7.1	Boys: 7.7 Girls: 6.4	7 yr: 5.7 8 yr: 6.4 9 yr: 8.0 10 yr: 7.6	NR	Urban: 7.4 Rural: 26.9[c]
Weight-for-height < –2SD	MOH, 2008 [12]	10.4 (9.8–11.1)	Boys: 10.6 (9.8–11.5) Girls: 10.2 (9.4–11.1)	< 1 yr: 15.2 (13.1–17.6) 1–3 yr: 15.1 (13.8–16.5) 4–6 yr: 9.4 (8.5–10.4) 7–9 yr: 7.5 (6.6–8.5) 10–13 yr: 4.5 (3.3–6.0)	Malay: 10.6 (9.8–11.5) Chinese: 7.4 (6.1–8.9) Indian: 16.8 (14.2–19.8) Other bumis: 8.9 (7.5–10.5) Others: 12.4 (9.4–16.3)	Urban: 11.0 (10.2–11.9) Rural: 9.5 (8.7–10.5)

BMI, body mass index; CI, confidence interval; MOH, Ministry of Health; NA, not applicable; NI, not included; NR, not reported; SD, standard deviation

a. Other bumis. (Bumis is a term which includes the indigenous groups: Ibans, Bidayuhs, Kadazans, Muruts, Penans, Lumbawang, Bajaus, those of Siamese descent, and Orang Asli (Aborigines).

b. Others include Caucasians, Eurasians, Portuguese, and anyone else who cannot be classified under any of the other major groups.

c. Data cited in paper from WHO, 1995 [29].

TABLE 3. Prevalence of overweight among children and adolescents in Malaysia

Cutoff	Author, year	Prevalence—% (95% CI where reported)				
		Both sexes	By sex	By age	By ethnicity	By locality
BMI-for-age > 95th percentile	Chee, 2008 [10]	NR	NR	6–9 yr: 0 10–17 yr: 5	NR	NR
BMI-for-age > 95th percentile	Moy, 2004; 2006 [13, 14]	7.3	Boys: 7.5 Girls: 7.1	Standard: 10.1 Form 2: 5.6 Form 4: 5.7	Malay: 7.8 Chinese: 6.7 Indian: 7.0	NR
BMI-for-age > 95th percentile	Tee, 2002 [20]	8.4	Boys: 9.7 Girls: 7.1	7 yr: 10.3 8 yr: 9.2 9 yr: 8.0 10 yr: 7.0	NR	NR
BMI-for-age > 85th percentile	Foo, 2006 [11]	4.5	Boys: 6.4 Girls: 2.9	NR	NR	NR
BMI-for-age > 85th percentile	Muhammad, 2008 [15]	27.4	NR	NR	NR	NR
BMI-for-age > 85th percentile	Zalilah, 2006 [23, 24]	18.3	Boys: 19.7 Girls: 16.7	11–12 yr: 19.9 13 yr: 18.6 14–15 yr: 16.1	Malay: 17.9 Chinese: 18.8 Indian: 17.8	Urban: 19.4 Rural: 17.3
Weight-for-age > +2SD	MOH, 2008 [12]	5.4 (5.0–5.7)	Boys: 6.0 (5.6–6.5) Girls: 4.7 (4.3–5.1)	< 1 yr: 4.1 (3.1–5.5) 1–3 yr: 3.2 (2.6–3.9) 4–6 yr: 6.4 (5.6–7.3) 7–9 yr: 6.8 (6.0–7.7) 10–13 yr: 5.9 (5.3–6.7) 14–15 yr: 4.8 (4.0–5.8) 16–18 yr: 4.3 (3.4–5.3)	Malay: 5.0 (4.6–5.5) Chinese: 7.1 (6.1–8.1) Indian: 8.1 (6.7–9.8) Other bumis: 3.7 (2.9–4.6)[a] Others: 3.9 (2.5–6.0)[b]	Urban: 6.3 (5.8–6.8) Rural: 4.0 (3.5–4.5)
Weight-for-age > +2SD	Rampal, 2003 [17]	5.3	Boys: 6.1 Girls: 4.6	6 yr: 7.1 7 yr: 7.7 8 yr: 4.4 9 yr: 4.3 10 yr: 2.8	NR	NR
Weight-for-age > +2SD	Saibul, 2009 [18]	0	NR	NR	NR	NR
Weight-for-age > +2SD	Zalilah, 2000 [22]	2.7	Boys: 3.1 Girls: 2.3	NR	NR	NR

Weight-for-height > +2SD	MOH, 2008 [12]	8.0 (7.5–8.6)	Boys: 9.0 (8.3–9.8) Girls: 6.7 (6.0–7.5)	< 1 yr: 6.2 (4.8–8.0) 1–3 yr: 5.0 (4.3–5.9) 4–6 yr: 7.8 (6.9–8.8) 7–9 yr: 9.8 (8.8–11.0) 10–13 yr: 14.0 (11.9–16.5)	Malay: 7.3 (6.7–8.0) Chinese: 10.3 (8.8–12.1) Indian: 8.4 (6.5–10.8) Other bumis: 8.4 (7.1–10.0) Others: 7.8 (5.5–11.0)	Urban: 8.8 (8.1–9.6) Rural: 6.8 (6.0–7.6)
Weight-for-height > +2SD	Tee, 2002 [20]	7.7	Boys: 9.5 Girls: 5.2	NR	NR	Urban: 7.7 Rural: 1.9[c]
At risk: BMI-for-age 85th–95th percentile	Rampal, 2007 [16]	11.4	Boys: 13.3 Girls: 9.7	13 yr: 13.3 14 yr: 12.9 15 yr: 12.6 16 yr: 8.1 17 yr: 9.6	Malay: 9.8 Chinese: 12.0 Indian:13.7 Others: 18.2	NR
Overweight: BMI-for-age > 95th percentile	Rampal, 2007 [16]	8.2	Boys: 10.6 Girls: 6.0	13 yr: 10.0 14 yr: 7.5 15 yr: 7.6 16 yr: 9.1 17 yr: 6.3	Malay: 10.7 Chinese: 5.9 Indian: 7.1 Others: 13.6	NR
At risk: BMI-for-age 85th–95th percentile	Soo, 2008 [19]	NA	Boys: NI Girls: 9.8	NR	NR	NR
Overweight: BMI-for-age > 95th percentile	Soo, 2008 [19]	NA	Boys: NI Girls: 8.6	NR	NR	NR
Overweight: 19.8 < BMI < 24	Zaini, 2005 [21]	16.8	Boys: 18.3 Girls: 14.2	NR	Malay: 14.8 Chinese: 23.0 Indian: 16.0	Urban: 17.6 Rural: 12.0
Obese: BMI > 24	Zaini, 2005 [21]	6.4	Boys: 6.5 Girls: 5.8	NR	Malay: 7.6 Chinese: 1.6 Indian: 5.1	Urban: 6.5 Rural: 5.4

BMI, body mass index; CI, confidence interval; MOH, Ministry of Health; NA, not applicable; NI, not included; NR, not reported; SD, standard deviation

a. Other bumis (Bumis is a term which includes the following indigenous groups: Ibans, Bidayuhs, Kadazans, Muruts, Penans, Lumbawang, Bajaus, those of Siamese descent, and Orang Asli (Aborigines).

b. Others include Caucasians, Eurasians, Portuguese, and anyone else who cannot be classified under any of the other major groups.

c. Data cited in paper from WHO, 1995 [29].

geographic location; this is probably due to different classifications of nutritional status. In Kuala Lumpur, the prevalence of underweight among children was 14.8% (BMI-for-age < 5th percentile) in 1994/95 in a survey by Moy et al. [13], 7.1% (weight-for-age < 2SD) in a 1996 survey by Tee et al. [20] and 8.1% (6.3 to 10.4) (weight-for-age < 2SD) in the NHMS-3 survey in 2006 [12]. The prevalence of overweight among children in Kuala Lumpur increased from 7.3% (BMI-for-age > 95th percentile) in 1994/95 [13] to 7.7% (height-for-age > +2SD) in 1996 [20] and to 9.1% (95% CI, 7.2 to 11.4) (weight-for-age > +2SD) in 2006 [12]. In Selangor, the prevalence of underweight among children was 10.0% (BMI-for-age < 5th percentile) in 2005 [32] compared with 10.6% (95% CI, 9.4 to 12.0) in 2006 [12]. In Selangor, the prevalence rates of children at risk for overweight (BMI-for-age 85–95th percentile) and overweight (BMI-for-age > 95th percentile) in 2005 were 11.4% and 8.2%, respectively [32]. In 2006, the NHMS-3 survey found that 6.5% (95% CI, 5.6 to 7.5) of children in Selangor were classified as overweight using weight-for-age > +2SD and 10.0% (95% CI, 8.6 to 11.6) using weight-for- height > +2SD) [12].

Sociodemographic characteristics

Sex

Estimates of underweight prevalence among boys were available from nine studies and ranged from 0.7% to 25.5% (**table 2**). Estimates of underweight prevalence among girls were available from 10 studies and ranged from 1.6% to 14.5%. Prevalence estimates for risk of overweight were available in a single study for boys (13.3%) and two studies for girls (9.7% and 9.8%) (**table 3**). Estimates of underweight prevalence among boys were available in 10 studies and ranged from 3.1% to 19.7%. For girls, 13 studies reported estimates of overweight prevalence that ranged from 2.3% to 16.7%. Almost all of the studies found a lower prevalence of underweight among girls than among boys (**table 2**) and a lower prevalence of overweight among girls than among boys (**table 3**).

Age

Direct comparisons between age groups across the studies were difficult, because the majority of studies included subjects with narrow age ranges or did not examine underweight and overweight status in relation to age. According to the NHMS-3, infants aged 1 to 3 years had the highest rates of underweight (19.8%; 95% CI, 18.4 to 21.3) [12]. Moy et al. reported the highest prevalence of underweight (16.1%) students in the youngest age group (Standard 5 students) compared with Form 2 (15.1%) and Form 4 (12.8%) students [13]. Zalilah et al. reported prevalence rates of underweight among children aged 11 to 12 years, 13 years, and 14 to 15 years as 11.4%, 11.9%, and 10.6%, respectively [23].

According to the NHMS-3 data, the prevalence of overweight among children and adolescents aged 0 to 18 years ranged from 3.2% to 6.8% [12]. The highest estimates for overweight were found among children aged 7 to 9 years (6.8%), 4 to 6 years (6.4%), and 10 to 13 years (5.9%). The lowest prevalence of overweight was found among children aged 1 to 3 years [12]. Among children aged 11 to 16 years, Moy et al. found the youngest age group (Standard 5 students) had the highest prevalence of overweight (10.1%) compared with Form 2 students (5.6%) and Form 4 students (5.7%) [13, 14]. Among students 13 to 17 years of age, Rampal et al. found that overweight prevalence was highest at 13 years of age (10.0%) and significantly decreased with increasing age to 6.3% at 17 years ($p < .0001$) [16]. Similarly, Zalilah et al. found the prevalence of overweight to be 19.9% among children 11 to 12 years of age, 18.6% among children 13 years of age, and 16.1% among children 14 to 15 years of age [23, 24]. Rampal et al. reported prevalence rates of overweight among children 6, 7, 8, 9, and 10 years old of 7.1%, 7.7%, 4.4%, 4.3%, and 2.8%, respectively [17].

Locality

Surveys that reported on urban and rural distributions of underweight children found a higher prevalence of underweight children in rural than in urban areas (**table 2**). These findings from smaller cross-sectional surveys were confirmed by the national survey in 2006, which reported a higher prevalence of underweight (weight-for-age < –2SD) among rural children (16.0%; 95% CI, 15.1 to 17.2) than among urban children (11.4%; 95% CI, 10.7 to 12.2) (**table 2**). Rural children were less likely to be overweight than urban children (**table 3**). The NHMS-3 found that 8.8% (95% CI, 8.1 to 9.6) of urban children were overweight (weight-for-height > +2SD), as compared with 6.8% (95% CI, 6.0 to 7.6) of rural children [12].

Ethnicity

Estimates of the prevalence of underweight and overweight according to ethnicity were inconsistent across studies. The national survey found the highest rates of underweight children (0 to 18 years of age) among Malays (14.3%; 95% CI, 13.6 to 15.0), followed by Indians (10.5%; 95% CI, 8.8 to 12.5) and Chinese (5.2%; 95% CI, 4.4 to 6.1). Among schoolchildren in Kuala Lumpur, Moy et al. found that Indians had the highest rates of underweight (21.1%), followed by Malays (15.9%) and Chinese (10.9%) [13]. A study among secondary school students in Klang District, Selangor, also reported high rates of underweight children among Indians (17.2%), followed by Malays (8.7%), Chinese (8.4%), and others (9.1%). A large cross-sectional survey of 6,555 school-aged students in

several states in peninsular Malaysia found the highest rate of underweight among Indians (19.2%), followed by Malays (11.9%) and Chinese (7.2%) [23].

According to the NHMS-3 data, Indian children had the highest prevalence of overweight (8.1%; 95% CI, 6.7 to 9.8), followed by Chinese (7.1%; 95% CI, 6.1 to 8.1) and Malays (5.0%; 95% CI, 4.6 to 5.5). In contrast, a number of studies found Malays had the highest prevalence of overweight, with the next highest prevalence among either Chinese or Indians. Moy et al. found that Malays had the highest prevalence of overweight (7.8%), followed by Chinese (6.7%), and Indians (7.0%) [13, 14]. Rampal et al. found that Malays had the highest prevalence of overweight (10.7%), followed by Indians (7.1%) and Chinese (5.9%) [16]. Zalilah, 2006 reported the order of highest to lowest prevalence rates of overweight to be Indians (19.2%), Malays (11.9%), and Chinese [23, 24]. Zaini et al. found the highest prevalence of overweight among Chinese (23.0%), followed by Indians (16.0%), and Malays (14.8%). The prevalence rates of obesity followed the reverse order: 7.6% for Malays, 5.1% for Indians, and 1.6% for Chinese [21].

Information on the nutritional status of indigenous populations was only reported in two surveys, the NHMS-3 in 2006 [12] and a study by Saibul et al. in 2002 to 2005, which examined a community of Orang Asli children [18]. Both surveys reported markedly higher rates of underweight and lower rates of overweight among children than among the general population (**tables 2** and **3**). Among Orang Asli children, the prevalence of underweight was 58.3%, and none of the children were overweight [18]. In the NHMS-3 survey, Orang Asli (Aborigines) were included in the category "other bumis," Bumis is a term which includes the indigenous groups Ibans, Bidayuhs, Kadazans, Muruts, Penans, Lumbawang, Bajaus, those of Siamese descent, and Orang Asli (Aborigines). Orang Asli were found to have an underweight prevalence of 18.4% (95% CI, 16.6 to 20.5) using weight-for-age (< –2SD) and 8.9% (95% CI, 7.5 to 10.5) using weight-for-height (< –2SD) (**table 2**). The prevalence of overweight children in the NHMS-3 survey under the category "other bumis" was 3.7% (95% CI, 2.9 to 4.6) based on weight-for-age (> +2SD) and 8.4% (95% CI, 7.1 to 10.0) using weight-for-height (> +2SD) (**table 3**).

Discussion

To our knowledge, this is the first review to critically summarize the prevalence, trends, and sociodemographic distribution of both underweight and overweight among children in Malaysia. Based on the most recent and representative estimates available, the prevalence of underweight is higher than that of overweight (13.2% vs. 8.0%) [12]; however, both types of malnutrition are present and indicate a serious public health problem. Recent observations in countries undergoing rapid economic development, such as Brazil, China, South Africa, and parts of the former Soviet Union, indicate that undernutrition and food insecurity continue to be prevalent, while at the same time, the prevalence rates of overweight and chronic metabolic diseases are on the rise [33]. Unlike some other developing countries undergoing rapid economic growth and urbanization, overall trends in the nutritional status of children in Malaysia do not indicate a decrease in underweight with an associated rise in the prevalence of obesity. Rather, the available evidence, although limited (based only on cross-sectional data) and sparse, suggests that over the past decade the rates of both underweight and overweight among children in Malaysia have been stable or have increased. An increase in the prevalence of both underweight and overweight suggests a potential increase in food insecurity and a widening of the gap between affluent and poor segments of the population [34]. There is evidence that the ratio of wealth between the richest and the poorest strata is an important determinant of differing rates of diseases within societies [34]. In countries in early transition, the poor and rural populations continue to suffer from undernutrition, while the affluent, often urban, minority is increasingly affected by the epidemic of noncommunicable diseases [34].

A potential rise in both underweight and overweight among children in Malaysia has significant social, economic, and public health implications. Both forms of malnutrition are linked to a range of adverse health conditions. Underweight children are susceptible to childhood growth problems and compromised mental development [35]. Overweight children are at risk for chronic diseases such as type 2 diabetes and a range of adult diseases such as obesity, stroke, hypertension, cardiovascular disease, and certain forms of cancer [36]. Long-term national monitoring and longitudinal studies of the nutritional status of children in Malaysia will be critical to understanding, preventing, and managing the double burden of malnutrition. Prospective cohort studies are needed to track underweight and overweight children into adolescence and adulthood. Quantitative longitudinal studies are needed to determine the relative importance of various determinants in influencing acculturation-associated changes in diet, physical activity levels, and sedentary behavior and the effects of these changes on health. Most of the current studies have examined urban samples, and therefore further research in rural areas and among disadvantaged populations (immigrants, refugees, Aborigines, lower socioeconomic groups, and minorities) is needed. Few of Malaysia's 13 states and 3 federal territories have been studied. Most studies to date

have been conducted in Peninsular Malaysia in either the state of Selangor or the federal territory of Kuala Lumpur. Further research is needed in East Malaysia (Borneo), which has different cultural, ethnic, and environmental factors affecting childhood nutritional status. Differences between ethnic groups in the prevalence of underweight and overweight can be due to a variety of factors. Among adult Malaysians, the Malaysia Non-Communicable Disease Surveillance-1 found that age, education, income, family history of illness, and smoking status were significantly associated with body weight across ethnic groups [37].

As future efforts continue to collect population surveillance data on the nutritional status of children in Malaysia, health researchers need to agree on a standardized definition of underweight and overweight among children for within-country comparisons. To address the need for a more international reference group and a less arbitrary cutoff point, Cole et al. analyzed large, nationally representative cross-sectional surveys from six countries to provide cutoff points for BMI in children 2 to 18 years of age and linked these to the widely accepted adult BMI cutoff points of 25 and 30 kg/m^2 [26]. WHO released new growth standards for children 0 to 60 months of age in 2006 and for children 5 to 19 years of age in 2007 that allow calculation of height-for- age, weight-for-age, and BMI-for-age, as well as assessment of other anthropometric indicators [1, 38]. These standards allow the calculation of overweight and obesity in children 0 to 60 months of age (BMI-for-age z-score > 2 for overweight and > 3 for obesity) and in children 5 to 19 years of age (BMI-for-age z-score > 1 for overweight and > 2 for obesity) [1, 38].

In addition to large national surveys, smaller surveys provide valuable in-depth information about risk factors and outcomes of poor nutritional status. Smaller studies need to employ strong methodologic techniques, such as random sampling to ensure the representativeness of samples, clear reporting of the year of data collection for time trend comparisons across studies, and the use of more current standardized definitions for underweight and overweight. More work is needed to try to understand the distribution of underweight and overnutrition, such as the clustering of underweight and overweight children in the same household and the co-occurrence of malnutrition disorders (e.g., stunting and obesity) in the same child.

The presence of underweight and overweight people within the same household (the so-called dual-burden household) is a relatively new phenomenon; its emergence is a result of the nutrition transition under way in developing countries that are becoming more prosperous and urbanized [39]. The sparse literature on dual-burden households has found the coexistence of child stunting and maternal overweight in the same household in developing countries undergoing a rapid nutrition transition [40, 41]. The phenomenon is reportedly less common in Africa than in Latin America or Asia [41]. A study in Africa found that dual-burden households shared several socioeconomic characteristics with households having members with protein–energy malnutrition and that food diversity appeared to be significantly associated with a lower likelihood of dual-burden status [41]. A study in Thailand found that overweight mothers with wasted children controlled their children's food intake and that wasted children consumed snacks more frequently but had lower energy intakes than children of normal weight [42].The dual-burden household poses a significant challenge for nutrition interventions, since programs targeted at underweight individuals may conflict with those targeted at the overweight [4].

As Malaysia continues to experience factors attributed to the nutrition transition, such as urbanization, sedentary lifestyles, and the liberalization of markets, the prevalence of overweight among children is expected to increase [43]. A critical issue in managing malnutrition is recognizing that underweight children are usually stunted. In Malaysia, the national prevalence of stunting among children (height-for-age < –2SD) in 2006 was 15.8% (95% CI, 15.1 to 16.6) [12]. Malnourished children who are underweight and stunted may gain significantly more weight-for-age than length-for-age. Stunting (growth retardation resulting from chronic undernutrition) has been associated with obesity later in life in several transitional countries, such as China, South Africa, and Brazil [44]. The combined objective of promoting child growth and preventing obesity is a major challenge to nutrition programs. If protein–energy malnutrition prevention programs are targeted on the basis of low weight-for-age, children with length deficits may become obese (high weight-for-length) while remaining underweight. Therefore, prevention programs need to include monitoring that will identify stunted overweight children.

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